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mental conditions on the floor of the rain-forest and in the tree tops one has only to contrast the large thin leaves of the terrestrial herbaceous plants with the small leathery leaves of the trees themselves. The shade, moisture and stillness of the forest floor form an environment well suited to such plants as the filmy ferns. It is surprising to find that they have emerged from these conditions and are to be found where the atmosphere is drier, where there is more wind and where they may even be struck at times by the rays of the sun. In spite of the hairy coatings that make it easier for them to live in relatively arid locations, they have in the main become adapted to drier conditions by the ability of their cells to lose much of their water for short periods without fatal results. This is much the same line of physiological evolution that has been followed by the desert species of *Cheilanthes* and *Notholaena*. These plants have retained all of the morphological features and most of the anatomical ones to be found in their congeners of moister climates. By means of an adaptation which is physiological rather than anatomical, these desert ferns are able to live under nearly the same conditions as the cacti, with their elaborate structural features for meeting conditions of drought.

In spite of the great diversity exhibited by the ferns of the world, we must regard them as having been conservative from an evolutionary standpoint, when we contrast them with flowering plants.

TUCSON, ARIZONA.

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### My Experiences with a Fern Garden

E. W. GRAVES

In 1908, while living in Clay County, Kansas, I found a colony of *Woodsia obtusa* growing on the eastern and northern exposure of what is called in Kansas a

rocky mound. In central Kansas there are several of these mounds rising some 200 ft. above the surrounding country. Under ledges of sandstone rocks I found a nice colony of the woodsia growing, the only fern I found growing wild in central Kansas, although I was told that *Cystopteris fragilis* grew in some places. I removed several plants of the woodsia to a flower garden I had planted on the north side of my house. I made a pile of stones and covered them partly with soil which I kept damp until the ferns had started to grow. They grew so well and covered the rockpile with such fluffy greenness that I decided to enlarge it and place more plants in it from the mound.

In August I made a trip to northwest Missouri to visit my old home of my boyhood days. I remembered I had seen growing in the woods the maidenhair and two other ferns, which at the time I did not know the names of. While in Missouri I hunted the woods and dug up clumps of the maidenhair and the two others which proved to be *Cystopteris fragilis* and *Athyrium filix-femina*, and by the help of a friend I found *Onoclea sensibilis*. These four ferns are the only ferns I have found in Nodaway Co., Mo., and I have searched the woods carefully during my boyhood days. I have recently read an account in the Fern Bulletin of *Osmunda cinnamomea* and I believe *O. regalis* being found in the south end of the County in later years. I took good roots of all four of the ferns from Missouri with me to Kansas and set them in my fern bed. This was my beginning of a fern garden, also my beginning of the real study of ferns.

In September of the same year my wife and I made a trip to Boulder, Col., and while exploring the mountains we came across several clumps of *Cheilanthes lanosa*, and *Pteris aquilina*, the latter being as high as my head. A few days later, while exploring Boulder

Canyon, I found several colonies of the male fern, *Dryopteris filix-mas*, growing along the water courses that flow into Boulder Canyon from the south. When I left I took with me roots of all three of the ferns with some Colorado Blue Spruce which I took back to Kansas and planted in my fernery.

In December I moved from Kansas to Long Island, Ala., taking all my ferns with me. I located on Sand Mountain plateau, the soil of which is very sandy, and is covered principally with heavy timber. To my delight I found the woods were full of ferns of different kinds. Before spring I had made out about a dozen different kinds from the dead fronds.

In the spring of 1909 I put my fern roots in a damp, shady place to keep them alive until I had built my house, and the following spring I prepared a fern bed on the north side of my house 24 ft. long and 6 ft. wide. Here I set all the ferns I had brought from the north, except *Cheilanthes lanosa* which had died.

I scoured the woods for miles around for new ferns to grow in my fern garden, and before the year was ended I had about 25 ferns growing nicely on the shady side of my house. I found my fernery was too small; I therefore enlarged it to 12 ft. wide. I soon found that some ferns require more water than others. Finally I solved that problem by building a concrete cistern or small reservoir at the west end of the fern garden which would collect the rain water from the roof of the house. Having a faucet at the lower east side I could irrigate the garden any time as the ground sloped a little to the east. I inclosed the fernery with a rock wall 3 ft. high for protection and to conserve the moisture. Each year I added new ferns which I found, and the fall of 1915 I had set about 60 different species in the fernery from several different states of the Union. But all did not grow. Of the California

ferns *Polystichum munitum* and *Woodwardia radicans* were the only ones that I could succeed in making grow. *Gymnopteris triangularis*, *Cheilanthes californica*, *Pellaea ornithopus*, and *Polypodium californicum* would not grow at all, although I received new plants several times. I received *Dryopteris filix-mas* from Idaho which did not grow, while those I brought from Colorado grew nicely and are still growing, and I was able to separate the clumps and send some to Mr. Joseph R. Mumbauer, of Pennsburg, Pa., in exchange for *Dryopteris cristata* and *D. cristata Clintoniana*. The two *Dryopteris* from Pennsylvania grew well and are still doing finely. I also received *Polystichum Lonchitis* from Mr. Mumbauer which grew very well for a year and died as Alabama was too far south for it.

In 1914 Miss F. E. Corne of Cambridge, Mass., sent me *Dryopteris Goldiana*, *Polystichum Braunii*, and *Phegopteris polypodioides* which I set in one corner of the garden and all grew off nicely for the first year. The second year *D. Goldiana* grew larger than the previous year, but *P. Braunii* showed signs of not being satisfied with the climate of Alabama. In 1916 it produced only very small fronds, and this year, 1917, it failed to appear. *Polystichum aculeatum* from California did about the same as its eastern relative—it lived two years and died. The Goldie's fern and the crested fern as well as the male fern seem to delight in the damp sandy soil of north Alabama. The long beech fern is still alive but develops only small fronds.

Along the Tennessee river, on damp limestone rocks, I found *Adiantum Capillus-Veneris* with fronds 3 ft. long. I transferred several clumps to the sandy soil of my fernery, placing pieces of limestone rocks around them, and they grew well for me.

The winter of 1916-7 was unusually cold with the thermometer several degrees below zero, and most of

the *A. Capillus-Veneris* froze out. *Cheilanthes Alabamensis* did very well by setting it among limestone rocks. *Asplenium montanum* I never succeeded in growing, although it grows only a half mile away on sandstone cliffs. I transferred it to my artificial cliffs and watered it regularly, but it always died in a few months. *A. Bradleyi* and *A. pinnatifidum* did a little better. I succeeded in getting one plant of each to adapt itself to my sandstone cliff. *Onoclea sensibilis* and *Pteris aquilina* proved to be almost a pest, and I had to cut back the roots, and pull out the fronds whenever they got out of their range. *Osmunda cinnamomea* and *O. regalis* I set near the reservoir where it was damp and they grew so large and took up so much room, that I was obliged to transfer them to a drier corner, and give *Dryopteris marginalis* and *D. spinulosa intermedia* the damp location, where they paid well with the beautiful evergreen foliage they produced.

I had one trouble to contend with which threatened some of my ferns. A whitish parasitic mold developed close to the ground on the bottom of the fronds of *Dryopteris filix-mas* and *Asplenium angustifolium*, and in a month or two the fronds of some of the plants withered and died, also killing the roots. I became alarmed for my choice ferns, but I soon discovered that a strong solution of lime-sulphur and arsenate of lead applied to the ground about the roots of the infested fern would destroy the parasite. This lime-sulphur and lead solution was what I had left from spraying my apple and peach trees, and I used it in the paste form. It saved my ferns, however, and I was glad I had stumbled onto the idea.

Two ferns I did not succeed very well in growing were *Scolopendrium vulgare* and *Trichomanes radicans*. I went to the South Pittsburgh station and dug up

several of the hart's-tongue and transplanted them in my fern garden several times but the ferns would live about a year and then die. By bringing some of the soil from the station, I did succeed in getting one to grow two years for me. The *Trichomanes* grows in its wild habitat only three miles away and I brought some home and prepared a damp shady cave for it, yet it failed to grow for me.

I derive much pleasure from my fern garden as I have many ferns growing near at hand for study, that otherwise I would have to go several miles to see.

LONG ISLAND, ALA.

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## An Annotated List of the Pteridophytes of Northwestern Ontario—II

O. E. JENNINGS

### OPHIOGLOSSALES

25. *OPHIOGLOSSUM VULGATUM* L. Not collected by us but reported as collected by Dawson at the extreme southwestern part of western Ontario, at the mouth of the Rainy River, Lake of the Woods.—*Macoun*.

26. *BOTRYCHIUM LUNARIA* (L.) Sw. This well distributed northern species was reported by Macoun from Pic River, Lake Superior; Nipigon Bay; meadows at Camp Alexander, Nipigon River; and at various points on Lake Nipigon. Our collections were from: Heron Bay; two stations at Rosspport; and Porphyry Island; all along Lake Superior.

27. *BOTRYCHIUM ONONDAGENSE* Underwood. Boggy trail near Grassy Lake, Thunder Cape. Reported heretofore from New York, Northern Michigan, and Montana, so that this station at Thunder Cape is probably the most northerly known.

28. *BOTRYCHIUM RAMOSUM* (Roth) Aschers. (*B. matricariaefolium* A. Braun; *B. neglectum* Wood.) Re-